INTERNATIONAL DESIGN CONFERENCE - DESIGN 2006
Dubrovnik - Croatia, May 15 - 18, 2006.

DESIGN 2006

DESIGN FOR PACKAGING LOGISTICS

J. Klevås

Keywords: IKEA, DFX, packaging, logistics

1. Introduction

The necessity of developing successful new products to face the fast-spinning, global market and to stay competitive is by no means news for companies today [Bowersox, Closs, & Cooper 2002]. The pressure is further amplified by shorter product life-cycles, diminished brand loyalty along with higher customer expectations. These issues have the result that contractors are forced to eliminate the debug, repair, and rework cycles if they are to stay competitive and continue to grow [Hoffman 1998]. The distributional performance is also crucial when a new product is to be delivered to its customer. But even though the product design has a great impact on logistics performance in the supply chain the distribution is usually considered very late in the product development process [Bjärnemo et al. 2000]. As a consequence, the product will not be designed to withstand the hazards and demands in the supply chain. The gap that arises between product characteristics and these demands can be unnecessarily big and has to be bridged by the packaging which usually is developed after the product design is decided upon. This makes the packaging design limited by the product design as well as by the logistical system [ten Klooster 2002].

1.1 Logistic demands

The aim of logistics, in the context of supply chain management, is to move and locate inventory, internally as well as externally, to achieve preferred time, place, and possession benefits at the lowest cost. The product and packaging design have a great impact on logistics efficiency. By taking in logistics demands (e.g. material handling, transportation modes, postponement strategies, warehousing etc.) in the design process, major cost and time reductions can be made [Bowersox, Closs, & Cooper 2002].

1.2 The role of packaging

Packaging is a necessity for the containment and protection of products from the environment but also for the protection of the environment from the products. In addition to marketing, protection and containment, the packaging also enables more efficient distribution and storage of products, which means that the packaging can help to reduce costs and cut lead-times in the supply chain. Tailor-made packaging and product design can also contribute to a reduction of packaging waste. [Bjärnemo et al. 2000; ten Klooster 2002]

1.3 Packaging and logistics considerations in the product development process

Packaging is usually a prerequisite for every product but also an important logistics activity because it is the packaged product that is transported, stored, carried, etc in the supply chain. The packaging design has the ability to facilitate logistics activities but the potential is usually not fully utilized because of product design limitations [Saghir 2004]. Several authors [e.g. Saghir 2004] emphasize the importance of packaging considerations in the product development process as this affects logistics

performance. Few attempts, however, have been made to actually suggest how this should be realized. In order to confront this issue Klevås & Saghir [2004] presented the Design For Packaging Logistics approach, inspired by Ulrich's & Eppinger's DFM approach [2000]. However, this attempt has not been tested empirically.

1.4 Purpose of the paper

The purpose of this paper is to bridge the gap between disciplines of engineering design, packaging and logistics by empirically testing the Design For Packaging Logistics approach, suggested by Klevås & Saghir [2004], based on the product development process of IKEA.
The paper is an empirical paper supported by a literature review within concurrent engineering, logistics and packaging.

2. Method

The paper is based on a literature review within packaging, logistics and Concurrent Engineering, with a focus on DFX-methodologies together with empirical data. The empirical data have been collected through a single case study at IKEA.
According to Yin [2003, p.13], a case study is "… an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." Yin [2003] claims that a single case can be the appropriate research design when the case represents a unique or extreme case.
IKEA is a product and packaging developing company which has control over a large part of its supply chain. This makes it possible to study the impact of product and packaging design decisions in the supply chain. IKEA has also been recognized as one of the world's most successful retailers and its success has been described as a result of a winning packaging and logistics strategy [Bowersox & Closs 2002].
Drawing on previous descriptions of IKEA, it can be seen as a unique case, hence motivating the choice of a single case study. Although the results can not be generalized statistically, they are to be seen as a first step within the areas of product development, packaging and logistics; an interface with very few contributions [Bjärnemo, Jönson, & Johnsson 2000].

2.1 The data collection

The author was offered a guest desk at the open-plan office of Business Area 50 at IKEA of Sweden, which made it possible to make direct observations. The main data collection methods have been interviews, review of internal and external documents, passive participation in product development meetings, informal "coffee-break meetings", observations in stores (including the sales area, unpacking operations and warehousing) and distribution centres. These data have been supplemented with information from the company's intranet and with interviews with a former manager at the packaging department. Having access to multiple sources of evidence is, according to Yin [2003], a good technique for improving construct validity. The interviews have been open-ended as well as semi-structured, starting with the open-ended interview in order to acquire a broader view and make it possible to sharpen and expand the questions. The informants include product developers, packaging technicians, product technicians, strategic purchasers , supply planners and employees in the stores and DCs.
The materials that resulted from the data collection have been compiled in a case study database and reviewed by key informants at Packaging Concept (a packaging competence function at IKEA of Sweden) and BA50 (a business area at IKEA of Sweden).

3. Including logistics considerations in the product development process

In order to encompass logistical considerations in the product development process, some authors have adopted the DFX approach. The concepts range from a supply chain perspective to a company level perspective (see Klevås & Saghir for a more detailed literature review).

The DFX approaches in logistics are quite diverse, and range from a supply chain perspective to a company internal perspective. Some aspects are, however, shared, i.e. the opportunity to reduce costs and lead times. The authors also point out the difficulty of quantifying the benefits that can be achieved when implementing the suggested approach. Packaging considerations are included in some of the DFX approaches, but it is somewhat unclear if this is the concern of the logisticians, the product developers or someone else due to the multidisciplinary characteristics and complexity of packaging.

3.1 Design For Packaging Logistics

The need for taking in packaging and logistics considerations during the product development process was identified by Klevås & Saghir [2004]. Based on empirical findings and a comprehensive literature review, they presented a conceptual DFX model, called Design For Packaging Logistics. The idea was to elucidate the product design factors influencing the packaging logistics activities in the supply chain in order to enhance the likelihood of successful product development. However, the authors did suggest that this model would need to be empirically tested.

4. Case description

IKEA was founded in 1943 and started as a mail-order firm. The first IKEA store was inaugurated in 1958 in Älmhult, Sweden. Today there are about 216 IKEA stores in 33 countries/regions, of which 192 are owned by the IKEA group. The IKEA group has 84000 co-workers in 44 countries and uses about 1500 suppliers in 55 countries (year 2004).
Significant for IKEA is that the end-consumers are used as manpower in terms of picking products from the warehouse storage racks in the store, arranging home distribution and carrying out the final assembly operations. Another distinguishing feature of IKEA is that they have control over the supply chain from the supplier to the end-consumer.

4.1 IKEA of Sweden

IKEA of Sweden is a part of the IKEA group located in Älmhult (in the south of Sweden) and it is here the main product development activities take place. IoS has 11 Business Areas (BA) which are responsible for product and packaging development of their particular collections.

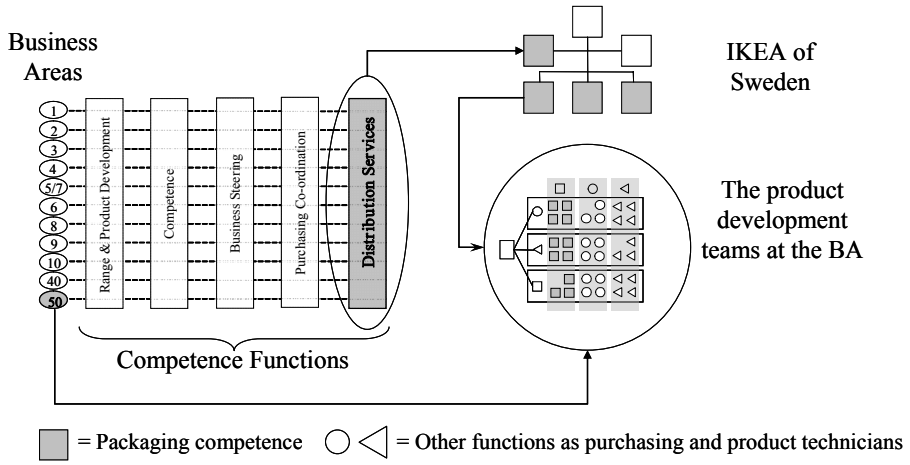

Figure 1. The organization of IKEA of Sweden (the organisation of the product development teams is inspired by Ulrich & Eppinger [2000, p.27]

The BAs are supported by centralized functions e.g. Distribution Services. Distribution Services is a logistics competence function which focuses on logistics issues at a strategic level. Packaging Concept is a part of Distribution Services and its mission is to develop and maintain the overall packaging strategy at IKEA. Packaging Concept has its own packaging technicians who carry out large

packaging projects for the BAs but they also support the packaging technicians located in the BA with packaging related issues. Figure 1 illustrates the organization of IKEA of Sweden and where the packaging competence is located. As the figure illustrates, the packaging competence is centralized/decentralized which has been recognized a great advantage for packaging awareness in the organization [Klevås 2005].

4.2 Product development at BA50

The products of BA50 include plants and outdoor furniture; frames and pictures; and Collections, e.g. Christmas and Easter decorations. The basic product development teams of BA50 consist of a product developer, a purchasing strategist, product technicians and a packaging technician. The purchasing strategists are grouped according to materials which makes them experts in potential suppliers for a specific product material The same goes for the product technicians, i.e. they are grouped based on product materials. These members are part of the team from the initial design briefing to the presentation of the finished product concept. Other members of the team who are involved occasionally during the development process are supply planners, the commercial manager, store support, etc. The product development process at BA50 can be described in five steps; Product Planning, Design Briefing, Design Review, Pre-product Council, and Product Council (see Figure 2).

4.2.1 Product planning

The team leader of the product development team, and the person who initiates a new product development project, is usually a product developer at the BA. The product developer has to attend the product development education program at IKEA where the "IKEA philosophy" is taught. It is the product developer, sometimes with the assistance of the Range Manager, who decides which products to keep and which new products to develop. Based upon this, an Action Plan (including function, material, price goal, forecast etc.) is developed.

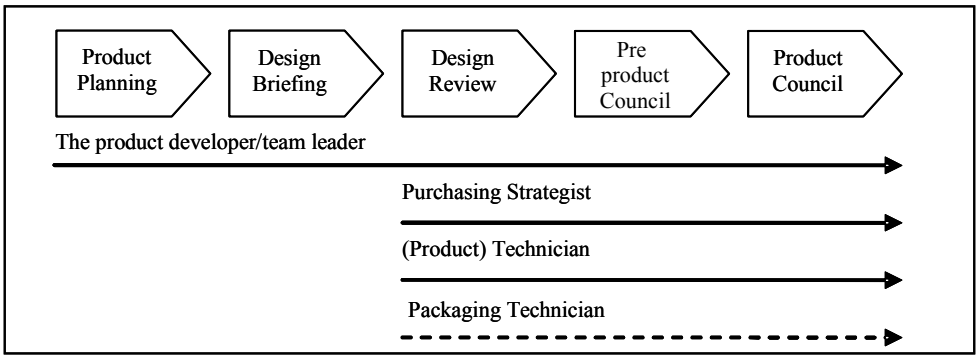

Figure 2. The product development process at BA50 [Klevås 2005]

4.2.2 Design Briefing

Usually a product designer is contacted, who gives the product developer a product design suggestion – i.e. the *design briefing*. The designer has to consider whether the product is to be disassembled or stackable. IKEA is famous for its flat packaging solutions. But there are limitations of how "flat" a packaging can be. The product has to be mountable with not too much effort for the customer.
During the product development process, it is also decided how the product is to be sold in the stores (e.g. in a multipack, on a half-pallet or on a pallet in the warehouse storage rack), in what quantities, what material to use and the potential supplying regions. When the technician is involved, it is still possible to make design changes. The packaging technician is involved if packaging is considered to be problematic. Otherwise, the packaging technician is used as a competence resource for the product technician. A prototype is built at IKEA's own modeling shop or at a product development supplier. The product technician also starts to consider possible packaging solutions, usually one for European

suppliers and another for Asian suppliers. The reasons for doing two packaging versions are that the pallet sizes differ, and in Asia the products are usually manually packaged while many European suppliers have automatic packaging lines.

4.2.3 Design Review

After the prototype has been built, there is a *design review*. This is the first decision point. During this review it is decided whether to go ahead with the project, whether to do a re-design if necessary or whether to stop development. After the design review, potential suppliers are contacted and risk analyses are made. Before the Pre-product Council, the product design, the packaging solution and potential suppliers are designated.

4.2.4 Pre-product Council

In this council, the product-to-be is presented to the co-workers and a final decision is made as to whether this will be a product in the range or not. The purpose of this council is to ensure that the product is ready for the product council, e.g. in terms of design, function, testing and approval, price, forecast, packaging solution etc. Usually the supply planner is involved after this council to make sure that the suppliers will be able to deliver the right quantities at the right delivery time.

4.2.5 Product Council

At the *Product Council* makes the formal and final decision to include the product in the range, and very few, preferably no, changes are to be made after this council. Following this council, orders are sent to the suppliers. After the orders have been sent out, there is a final inspection of the first production at the suppliers. Sampling tests are taken and (if applicable) the product is tested for customer assembly. This final inspection is considered very important because of the extremely large quantities that are to be produced at the same time. The quality of the products is checked, as well as the packaging solution (quality, information, the location of symbols and labels etc.).

4.2.6 Focus groups

After the approval of the final inspection the products are sent to a central warehouse. Three months after the product has been launched at the stores, there is a follow-up by a focus group to investigate if the sales figures are as expected, if the product is in short supply, if there are quality problems etc. The focus group usually includes the supply planner, the product technician, and the Commercial Manager. They receive input from the stores concerning deliveries, packaging issues etc. and are responsible for handling problems that emerge. The team leader is usually not included in this group (as the next product development project has to be planned for), but has a continuous dialogue with the group members, especially if quality problems arise. The work of the focus group also results in input for new product development projects.

5. Design For Packaging Logistics at IKEA

The product development process of BA50 at IKEA has been applied on the Design For Packaging Logistics model as illustrated in Figure 3. The logistical and packaging input via the product development team members in the different stages of the product development process can be summarized as follows:

5.1 Product planning

- Focus groups (follow-ups from last product development projects). These focus groups make sure that poor packaging solutions are not repeated.
- IKEA's internal education for product developers. The education, which is compulsory for all product developers, includes knowledge about the IKEA supply chain and the importance of a sufficient packaging solution. Pallet adaptation and filling rates is therefore a knowledge that every product developer possess.

5.2 Design Briefing

Supply chain requirements:

- Packaging Concept, located in the logistics competence function at IKEA, gives supply chain input via the packaging technicians. Packaging Concept is located in the logistics competence function at IKEA and is continuously updated concerning supply chain strategies which can be implemented in the packaging strategy. This also means that Packaging Concept can give packaging input to the logistics strategy.
- Input from the stores concerning handling and unpacking. IKEA collaborates with a few stores which updates the Business Areas on a regular basis. The goal is to minimize the unpacking times and maximise product presentation in the stores.
- Input from the warehouses concerning handling and storage.
- Manufacturing conditions at potential suppliers is given by the purchasing strategist. The purchasing strategist is also familiar with packaging lines, i.e. if an automatic packing line should be used or if the product should be manually packed, at the potential suppliers. This information is very important for the packaging design.

Packaging requirements:

- Product developer: exposure in the stores
- Packaging technician: possible laying patterns witin the packaging, the use of single packaging material, packaging material characteristics, Asian and European version.
- Purchasing strategist: potential supplying regions (packaging equipment – manually or automated, labor costs, infrastructure, pallet type)
- Product technician: input from the stores, warehouses and suppliers concerning handling and storage conditions

Logistical requirements:

- Packaging technician: Asian and European packaging version for better transport utilization and material handling efficiency
- Purchasing strategist: potential supplying region characteristics, e.g. can a EURO-pallet be used or would a cardboard pallet be better? Different pallets have different strengths which influences the maximum weight of the products.
- Product technician: level of customer assembly. There is a limit of how much a product can be reassembled for high distribution efficiency. It must be possible for the end-consumer to assemble the product without help from expertise.

Product requirements:

- Product developer: stackable or mountable product
- Packaging technician: trade-offs between logistical friendly packaging solution and level of assembly
- Purchasing strategist: expert in suppliers for chosen product material
- Product technician: expert in the chosen product material

5.3 Design Review

- Product development team: First decision point. A prototype is build and estimated according to packaging, logistical and product requirements. If the requirements are not fulfilled, the team has to decide whether to stop development or to make design changes.

5.4 Pre-product Concil and Product Council

- Input from BA manager, Commercial Manager, Supply planners, Test suppliers etc. Only small adjustments can be made and packaging and logistics input is usually too late to be considered in this phase.

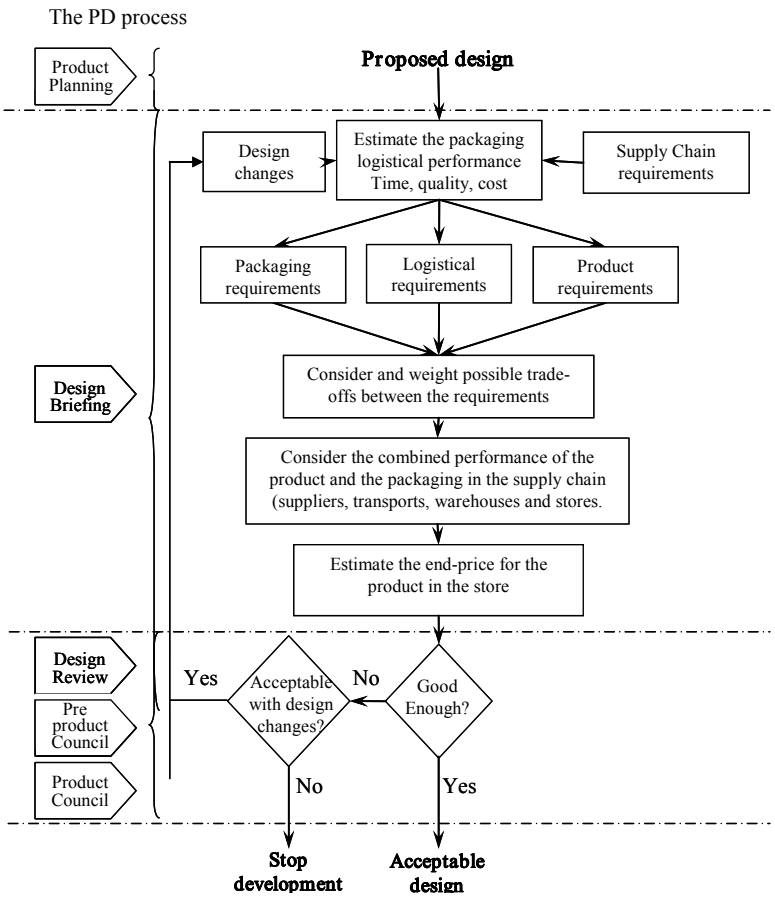

Figure 3. Design For Packaging Logistics at IKEA

6. Conclusions

Using the Design For Packaging Logistics approach on the product development process of IKEA elucidates how packaging and logistics considerations are integrated in the product development process through the involvement of packaging and logistics competence. The DFPL approach can be used with few modifications on the IKEA case. As the DFPL approach is based on literature and on gleanings from case studies, it can be concluded that IKEA is at the cutting edge when it comes to packaging and logistics in the product development process.

IKEA is a unique company, not only for possessing such great power over its supply chain but also for including packaging and logistics in its product development process. IKEA is continuously working for the enhancement of logistics performance in its supply chain, and improved packaging and product design are one way to reach this goal. The organization of IKEA is also continuously changing to support logistics and packaging competence. However, IKEA's uniqueness should not be seen as a hindrance. It is the author's belief that many features of the DFPL approach can, and should, be applied to other product developing companies. In general, every product needs packaging, so many issues that IKEA is struggling with are most certainly similar to issues faced by other product developing companies. IKEA has the advantage of being to measure, and benefit from (!), new packaging and supply chain solutions. But it is the author's belief that even companies with little control over the supply chain can benefit from a more holistic perspective. The idea of product development is for a company to go from a business opportunity to land in the shopping cart of the

consumer in order to stay competitive on the market. This requires market knowledge, product design expertise as well as extensive knowledge in packaging and logistics. When there is little insight into supply chain demands, and packaging knowledge is poor, logistically-friendly products are unlikely to be developed.
The DFPL approach can not be used to compensate for the lack of packaging and logistics professionals in the product development process, it should rather be used to point out the need for, and justify, these competences and how they can be used during product development.

6.1 Concluding remarks

The DFPL approach is by no means a static model or framework. It can, and should, not be applied on other companies without modifications. It is the author's intention to continue to further refine and develop the DFPL approach on other product developing companies. This can be done by studying both companies where packaging development is integrated in the product development process and companies where it is not. The impact packaging decisions have on supply chain performance can then be studied and the model may be refined. However, the purpose of the DFPL approach is not to be a model applicable without modifications, it should rather be seen as a source of inspiration and a tool to elucidate the impact product and packaging design has on logistics efficiency in the supply chain. Developing the packaging concurrently with the product *and* with a constant dialogue with the other team members almost certainly guarantees better product design trade-offs. The DFPL approach can be a tool to reach that goal.

References

Bjärnemo, R., Jönson, G., & Johnsson, M., "Packaging Logistics in Product Development", Proceedings of the 5th International Conference: Computer Integrated Manufacturing Technologies for New Millennium Manufacturing, J. Singh, S. C. Lew, & R. Gay (Ed.), Singapore, 2000, pp. 135-146.

Bowersox, D. J., Closs, D. J., & Cooper, M. B., Supply Chain Logistics Management, First International edn, McGraw - Hill / Irwin, New York, 2002.

Hoffman, D. R., "An overview of concurrent engineering", Proceedings of the Reliability and Maintainability Symposium, Annual, 1998, pp. 1-7.

Klevås, J., "Organization of packaging resources at a product-developing company", International Journal of Physical Distribution & Logistics Management, Vol. 35, No. 2, 2005, pp. 116-131.

Klevås, J. & Saghir, M., "Introducing the Concept of Design For Packaging Logistics", Proceedings of the international Conference of Productitivy and Quality Research, Miami, USA, 2004.

Saghir, M., A platform for Packaging Logistics Development - a systems approach, Doctoral thesis, Department of Design Sciences, Division of Packaging Logistics, Lund University, Sweden, 2004.

Ten Klooster, R. Packaging Design: a methodological development and simulation of the design process, Doctoral thesis, Delft University of Technology, 2002.

Ulrich, K. T. & Eppinger, S. D., Product Design and Development, second edn, McGraw-Hill Companies, Inc. 2000.

Wilding, R. D. & Yazdani, B., ""Concurrent Engineeering" in the Supply-Chain", Logistics Focus, Vol. 5, No. 2, 1997, pp. 16-22.

Yin, R. K., Case Study Research: Design and Methods, Third edn, Sage Publications, California, 2003.

Jenny Klevås, MSc ME, Tech.Lic.
Ph.D. Student
Institution of Design Sciences/University of Lund, Department of Packaging Logistics
P.O. Box 118, SE-221 00 Lund, Sweden
Tel.: +46 46 222 3943
Fax.: +46 46 222 8060
Email: jenny.klevas@plog.lth.se